INSTRUCTIONS

TROUBLE-SHOOTING

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INTRODUCTION

This section presents trouble-shooting procedure as an aid for correcting locomotive problems to keep the locomotives "on the line." It lists some of the troubles which may occur, along with most probable causes and corrections which will restore normal working order.

The information contained in this guide deals with those problems which could be corrected on the road or at a terminal, with a minimum of time and repair equipment.

Certain problems are related to visual and audible warning indications received by the operator. Causes of some of these indications are common operating failures normal to operation of a road locomotive, yet easily overlooked.

These correction procedures should be performed by qualified personnel having a working knowledge of the overall locomotive systems. Familiarity with the necessary test equipment required to perform these tests and adjustment procedures is also necessary.

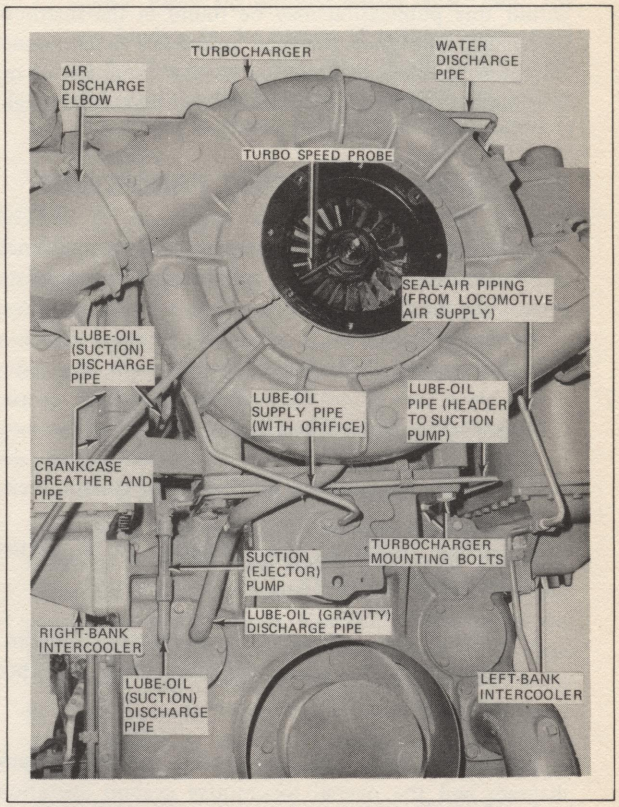

FIG. XII-1, E-24459

FIG. XII-1. TURBO DETAILS, COMPRESSOR END.

These instructions are intended for the general guidance of assigned personnel. The suggested corrections are stated briefly to enable an experienced maintainer to rapidly scan the lists and pinpoint the necessary correction for a specific trouble. They are not intended to provide an exhaustive treatment of safety precautions or procedures for any individual, experienced or inexperienced, with regard to installation, removal, operation, maintenance or repair of the equipment. In all instances local safety rules should

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

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prevail. Input power should be removed before making changes or connections to all electrical equipment, and air pressure should be released or isolated before changing pneumatic connections.

Before any adjustments are made, proper trouble-shooting should be performed to isolate the problem and identify the need for adjustment.

Adjustment of assemblies or components not covered within this publication may be found in the instructions specifically published for such assemblies or components. For more detailed information on any condition or repair procedure, refer to the locomotive Maintenance Manual.

TROUBLE-SHOOTING PROCEDURE

Trouble-shooting is the process of locating a malfunction and correcting it. Basically, trouble-shooting consists of performing the following steps:

1. Recognizing that a problem exists
2. Analyzing the problem
3. Isolating the problem to a particular system or circuit
4. Further isolating the problem to a particular component or device
5. Making the necessary replacement, repairs or adjustments to place the unit back into proper operation.

Familiarity with the locomotive system schematic diagram and the overall locomotive system operations is required for rapid, logical trouble-shooting.

It is assumed, when trouble-shooting printed circuit cards, maintenance personnel will substitute "good" (spare) cards for suspected malfunctioning cards as a means to isolate the problem to an individual card.

It is assumed that failed and defective cards and devices will be replaced with new or repaired-tested equipment.

Before applying power for trouble-shooting, maintenance personnel should perform a check for wiring faults or grounds.

This section does not cover all malfunction possibilities. It is written to suggest specific functional system tests to aid in trouble isolation and, also, procedures for system adjustments.

SAFETY NOTICE

WARNING: *Electrical shock can cause serious or fatal injury. Proper precautions should be observed by personnel performing the trouble-shooting and adjustments.*

WARNING: *Before removing or dismantling any pneumatic component or pipe joint, the locomotive must be safely parked, and the component or pipe joint must either be isolated by the use of an appropriate cut-out cock, or all air pressure on the locomotive must be vented. Failure to comply with this warning notice could result in physical injury.*

WARNING: *When using compressed air for cleaning purposes, an environment potentially hazardous to personnel in the immediate area is created. To prevent physical injury by flying debris, observe all Railroad and OSHA safety regulations.*

CAUTION: *Power should be removed when pulling or replacing electronic cards, to prevent electrical damage to the cards and their contacts in the panel.*

The General Electric Company has made every effort to provide safeguards for all its equipment to reduce hazards to a minimum. However, success in accident prevention can be achieved only through the cooperation of every person conducting these trouble-shooting and adjustment procedures. The most effective methods of preventing accidents during testing of electrical equipment are alertness, caution and safe habits.

In general, the following rules apply:

1. Areas involved in test operations shall be conspicuously identified with suitable warnings.
2. Do not inspect any high-voltage compartment (or compartment identified with a warning sign) when locomotive is energized.
3. Do not remove any component card or device when locomotive is energized.
4. Do not touch motors, switches, protective barriers or other electrical apparatus without being fully instructed as to their use.
5. All circuits not known to be "dead" are to be considered "alive and dangerous" at all times.
6. Air and/or handbrakes on the locomotive must be applied or wheels blocked at all times, except when locomotive movement is required.

TROUBLE-SHOOTING GUIDE

The following procedures are not all-conclusive and should not be used as a substitute for normal railroad trouble-shooting procedures. These procedures are a general guide to be used in addition to the normal railroad trouble-shooting procedures as a further aid to the maintainer. It should also be noted that an overall visual inspection and check procedure is not included but is covered in Section II, "Inspections and Checks."

PRELIMINARY CHECK (ENGINE SHUT DOWN)

When a unit is sitting on the incoming track ready to be brought into the shop, check the following:

1. All available engineer's reports for trouble
2. Check line-of-road reports for reported troubles
3. Check past work reports on the unit for repeats
4. Then go to the unit.
   a. If the engine is shut down on arrival, check the Annunciator Panel and the two holding relays, Engine Temperature Holding Relay (ETHR) and Governor Shut Down Holding Relay (GSDHR), for lit indicator lights and check all safety shutdown devices. Close the battery switch if it is open. If any indicator lights are lit or safety shutdown devices are found tripped, determine the reason and correct. If no lights are lit and none of the devices are found tripped, make a thorough crankcase inspection in all doors looking for dripping water, broken cylinder skirts, scored liners, traces of fine metallic particles on internal surfaces and ledges of the crankcase or signs of heat on any of the main or rod bearing caps. If any of these conditions are found, not only the appropriate repairs on these items may be necessary, it will also require checking items such as the following:
      1) Lube-oil pump bearing housing for signs of heat
      2) Oil in the crankcase for water and/or viscosity out of limits
      3) Water level in the sight glass on the water tank
      4) Fuel pressure by starting fuel pump.
   b. Remove the cylinder valve covers and inspect each cylinder for broken or stuck valves, broken rocker levers or push rods, loose or missing tappet nuts, loose valve keepers, loose locknuts or any unusual condition that may be evident.
   c. If nothing is found up to this point, open the cylinder relief valves and manually bar the engine over two complete revolutions. While barring over, look for water coming out of the relief valves, listen for unusual noises, and "feel" for any binding in the engine. If nothing is observed up to this point, close the cylinder relief valves and carefully try to crank the engine. Do not try to help the engine to start by moving the layshaft manually.

NOTE: *If an engine does not fire within sixty seconds and fuel pump racks do not come out to 11-13 mm while cranking, it probably is not going to start. To avoid running the battery down, do not continue cranking the engine. If permitted by railroad rules, pull the racks on two (only) injection pumps out to "full rack" while cranking. If the engine still does not start, leave it dead and proceed to investigate the possible cause.*

5. Table XII-I lists the most common causes of engine cranking problems and engine shutdown problems. Table XII-II presents a more detailed listing of engine component malfunctions, electrical malfunctions and locomotive systems malfunctions including some "one time only" occurrences. It should be noted that in some cases in Table XII-II, more than one shutdown device is shown as being activated for a particular cause. Although two devices may be activated, only one is required for engine shutdown.

   Also, it should be noted that the POSSIBLE CAUSE column in Table XII-I lists the causes in descending order of probability. Thus, the first cause listed is the most probable cause of the problem and the last cause listed is the least probable cause.

PRELIMINARY CHECK (ENGINE RUNNING)

If the locomotive arrives with the engine running at idle, check the following:

Operator's Cab

1. Engine lube-oil pressure should be 20 psi (minimum).
2. Fuel-oil pressure should be 40 psi (minimum).

TABLE XII-I, ENGINE TROUBLES

Problem	Possible Cause	Correction
ENGINE WON'T START		
Fuel pump won't run.	GSDHR is tripped.	Reset after analysis of fault.
	COP is tripped.	Reset after analysis of fault; see Crankcase Overpressure tripped under Engine Shutdown Devices.
	Shutdown signal has been sent to engine.	Check all other devices including contacts on Emergency fuel shut-off and Engine Stop push-buttons.
Engine won't crank (contactors don't operate).	Fuel pump is not operating.	Reset after analysis of fault.
	Barring Over Switch (BOS) is open.	Replace cover on barring over drive or connect cable.
Engine won't crank (contactors operate).	Start circuit is malfunctioning.	Check brushes and commutators in auxiliary generator and exciter; check cables and start circuit. Also, check for 74 vdc battery voltage.
Engine won't start (governor gap is greater than 1 in.).	Stop signal is being sent to governor.	Move Throttle handle from SHUTDOWN to IDLE position to clear stop signal to the governor speed solenoid (DV).
	One or more engine shutdown devices tripped.	Determine which device(s) is tripped and the cause. See Engine Shutdown Devices.
Engine won't start (governor gap is approximately 3/4 in.; rack setting is less than 10 mm).	Overspeed system malfunction.	Reset if tripped. Check overspeed governor output pressure during cranking. Pressure should not be less than 95 psi. If pressure is less than 95 psi, replace overspeed link and/or governor regulating valve.
	Mis-adjusted overspeed governor.	Adjust overspeed governor.
Engine won't start (governor gap is approximately 3/4 in.; rack setting is 11 to 13 mm.).	Fuel supply low, problem with fuel line or very low fuel pressure.	Check fuel supply and fuel line. If needed, add fuel. Determine and correct the cause of low fuel pressure.
	Timing is incorrect.	Reset timing.
	Cranking speed is too slow.	Check battery condition.
ENGINE SHUTDOWN DEVICES		
Low Oil Pressure (LOP) tripped. (This is an automatic reset.) **NOTE:** *GSDHR will also be tripped. Reset after analysis of fault.*	Low oil level.	Add oil.
	Dirty oil filters.	Replace filters.
	Open filter tank drain-back valve (C).	Close valve.
	Dirty lube-oil cooler (oil side).	Replace cooler tube bundle.
	Dirt in crankcase oil strainer or loose cover.	Replace strainer; secure cover.
	Faulty lube-oil relief valve.	Replace valve.
	Dirty fuel filter or strainer.	Replace filter or strainer.
	Failed (slipping) bonded pump drive.	Replace bonded pump drive.
	Hot oil because of low viscosity.	Determine and correct the cause of low viscosity such as dirty oil filters, dirty lube-oil coolers, and dirty crankcase oil strainer.
	Failed oil pump.	Replace oil pump. Also, examine engine bearing caps and housings for signs of excessive heat; investigate and correct cause.

TABLE XII-I (Cont'd.)

Problem	Possible Cause	Correction
	Excessively worn engine bearings.	During crankcase inspection look for evidence of bearing metal on all crankcase ledges. Carefully inspect bearing caps for signs of distress.
	Worn governor drive gear box shaft bearings.	Replace bearings.
	Wrong dipstick.	Replace with proper dipstick and recheck oil level.
	During cold weather, oil in the dead-end pipe to the governor's low lube-oil pressure device becomes very thick.	Modify the dead-end piping to bypass. (See GEMS, Volume V, Issue 2 dated Sept. 30, 1977.)
	Defective diaphragm in governor.	Replace diaphragm.
Low Water Pressure (LWP) tripped. (This is an automatic reset.)	Low water level.	Add water. Also, inspect locomotive cooling system for leaks. Remember that the radiators on General Electric locomotives are dry unless the water temperature is high enough to send water to the radiators (with engine running). Inspect the crankcase for cylinder water leaks; check for water in oil.
	Boiling water at pump inlet.	Check for low water level or malfunctioning thermostat (pellet).
	Cooling system not pressurized.	Examine the fill cap for a good gasket, good fit to the fill pipe, and for proper application of the fill cap. Also, check for cracked water tank or sight glass.
	Dirty lube-oil cooler (water side).	Replace cooler tube bundle.
	Lube-oil cooler water inlet screen is plugged.	Remove debris and clean screen.
	Dirty fuel filter or strainer.	Replace filter or strainer.
	Failed (slipping) bonded pump drive.	Replace bonded pump drive.
	Defective diaphragm in the governor pressure switch.	Check for water leakage at the low water pressure switch on the governor; replace diaphragm.
Crankcase Overpressure (COP) tripped.	Oil level too high.	Pull the dipstick and check for oil level being too high. Perform test to check for presence of water in crankcase. Excess level in crankcase may be caused by cylinder seals leaking water. Make a crankcase inspection to look for water dripping from either the inside of the cylinder bore (top seal leak) or from the bottom outside part of the cylinder skirt (lower liner seal leak).
	Cylinder blow-by.	Perform blow-by test to detect defective cylinder or piston; replace defective component(s).
	Plugged or inverted crankcase breather screen.	Clean screen; check for proper installation.
	COP switch out of calibration.	Recalibrate switch.
	Defective switch.	Replace switch.

TABLE XII-I (Cont'd.)

Problem	Possible Cause	Correction
OTHER ENGINE TROUBLES		
Hot engine.	Severe cooling water system-related problem.	Check cooling water system; see items listed under Low Water Pressure (LWP) Tripped. If no fault is found with the cooling water system, tests the LOTS switch. It may not be indicating that a high lube-oil temperature has occurred.
	Failed fan drive.	Check that fan is running. On a General Electric locomotive, the fan always runs while the engine is running.
	Dirty radiator air passages.	Clean radiators.
	Plugged air inlet screens.	Clean screens.
	Dirty lube-oil cooler (either side).	Replace cooler tube bundle.
Engine Overspeed (O/S) tripped.	Stuck control rack linkage.	Remove governor link pin and check control linkage for binding.
	Defective overspeed governor or set too low.	Replace overspeed governor, or reset in place on engine. Overspeed should be set for 1150 engine rpm (1708 rpm at tach drive).
	Injection fuel pump racks stuck open.	Reset racks or reduce linkage binding.
	Defective engine governor.	Replace governor.
Low fuel pressure.	No fuel.	Check fuel in tank; add fuel.
	Dirty fuel strainer.	Clean strainer.
	Suction leak in line.	Locate leak and repair.
	Dirty fuel filter.	Clean filter.
	Defective fuel transfer pump motor.	Replace motor.
	Regulating valve set too low.	Reset valve to 40 psi.
	Relief (safety) valve leaks.	Replace valve.
	Relief (safety) valve set too low.	Reset valve to 75 psi.
Fuel dilution.	Defective nozzle.	Pop-test each cylinder to check for weak and/or not firing cylinder. Repair or replace nozzle.
	Defective fuel injection pump.	Replace fuel pump.
	Cold engine.	Replace thermostat. Clean orifices in pilot valve.

3. All circuit breakers on Engine Control Panel closed or "ON."
4. No indicating lights lit or alarm bells ringing.
5. Battery switch closed.
6. Operator's control console switches set-up for proper operation.
7. Air brakes set-up for proper operation.
8. All air pressure gages at normal.
9. Power Limit (7th Notch) Switch in NORMAL OPERATION position.
10. Reverse handle in NEUTRAL position.
11. Generator Field switch in OFF position.
12. Pop-test all cylinders, and listen carefully for any unusual noises coming from the engine.

Engine Room

1. Sides of engine for fuel, oil or water leaks.

TABLE XII-II, SUMMARY – CAUSES FOR ENGINE SHUTDOWN

Item	Cause	Result					
		Low Oil Pressure (LOP)	Low Water Pressure (LWP)	Crankcase Over-Pressure (COP)	Engine Over-Speed (O/S)	Fuel Problem (Fuel)	None
ENGINE							
1.	Low oil level	X					
2.	Failed bearing/bearings	X					
3.	Lube-oil pump failed	X					
4.	Overspeed governor low output pressure	X	X				
5.	Overspeed link failed	X	X				
6.	Low oil diaphragm failed	X					
7.	Low water diaphragm failed		X				
8.	Low engine speeds	X	X				
9.	Stuck racks	X	X		X		
10.	Defective load pot	X	X				
11.	Engine bog due to sticky fuel linkage	X	X				
12.	Low lube-oil viscosity (fuel dilution)	X					
13.	Bonded-rubber pump drive sheared	X	X				
14.	Pipe plug missing from cavity in top of forward-end cover	X		X			
15.	Plugged crankcase breather			X			
16.	Crankcase breather screen inverted (large mesh up)			X			
17.	Broken crankcase eductor			X			
18.	High oil level			X			
19.	Water pump failed		X				
20.	Wrench on layshaft				X		
21.	Failed governor drive						X
22.	Faulty governor	X	X				
23.	Engine overspeed (true overspeed)				X		
24.	False engine overspeed (cover or adjustment screw loose)				X		
25.	Fuel-injection pump rack or fuel linkage stuck	X	X		X		
26.	Faulty overspeed governor				X		
27.	Failed turbocharger	X	X				
28.	Plugged intercoolers	X	X				
29.	Inlet port carbon	X	X				
30.	Cracked piston			X			
31.	Stuck rings or scored liners			X			
32.	Dry piston rings (after extended shutdown)			X			
33.	Cracked piston crown			X			
34.	Wrong piston rings applied			X			
35.	Cylinder water leaks (into crankcase causing oil level to be too high)			X			
ELECTRICAL							
1.	Dynamic braking for long period and at high ambient temperature	X					
2.	Engine won't crank						X
3.	Faulty COP switch			X			

TABLE XII-II (Cont'd.)

Item	Cause	Result					
		Low Oil Pressure (LOP)	Low Water Pressure (LWP)	Crankcase Over-Pressure (COP)	Engine Over-Speed (O/S)	Fuel Problem (Fuel)	None
ELECTRICAL (Cont'd.)							
4.	GSDHR tripped						X
5.	Intermittent fuel cut-off switch or ENGINE STOP push-button						X
6.	Emergency shutdown on throttle						X
7.	ENGINE STOP push-button has been pressed						X
8.	Excessive excitation	X	X				
9.	Control grounds	X	X				X
10.	Transition transients	X	X				
11.	Fuel pump relay coil failed						X
12.	Fuel pump motor failed	X	X				
LOCOMOTIVE SYSTEMS							
1.	Blocked oil pan strainer	X					
2.	Cover off oil pan strainer or defective cover gasket	X					
3.	Filter drain-back valve (C) open	X					
4.	Plugged lube-oil cooler (oil side)	X					
5.	Plugged lube-oil cooler (water side)	X	X				
6.	Low water level		X				
7.	Water-tank fill cap missing or loose fit or defective		X				
8.	Water storage tank: defective baffle or splitter, blocked screens, cracks in tank		X				
9.	Water leak		X				
10.	Hot water (causes hot and low viscosity oil)	X					
11.	Relief lube-oil valve set too low	X					
12.	Plugged fuel filter	X	X				
13.	Plugged engine air filters	X	X				
14.	Lube-oil level too high			X			
15.	Wrong lube-oil dipstick	X		X			
16.	Blocked breather pipe at the exhaust stack			X			
17.	Air blow down (at lube-oil filter change)			X			
18.	Leak in oil line between O/S governor and link				X		
19.	Fuel tank empty					X	
20.	Low or no fuel pressure	X	X			X	
21.	Excessive leakage in fuel suction line or in seal of fuel transfer pump	X	X			X	
22.	Ice in fuel tank or fuel strainer, or waxed-up fuel strainer					X	
23.	Plugged lube-oil filter	X					
24.	Wrong exhaust stack			X			
25.	Broken oil pipe	X					
26.	Hot oil	X					
27.	Low or no radiator cooling (dirty radiator, fan stopped, etc.)	X	X				

XII

2. Oil level (at or near full mark).

3. Water temperature gage (150 to 170 F).

4. The water sight level glass (at approximately 170 F, water should be near HIGH at IDLE mark).

5. Water pump for seal leak (check for water drip onto platform).

6. Water fill (pressure) cap is in place.

7. Air compressor for oil leaks.

8. The radiator fan is turning.

9. Dynamic braking grids for burned or open ribbons and broken insulators or barriers.

PRELIMINARY CHECK (COLD WEATHER)

The following checks should be performed to help prevent cold weather trouble and possible road shutdown. These checks are in addition to the normal railroad checks and procedures for cold weather service.

1. Assure there are no breaks in the traction motor air ducts that would permit moisture to enter.

2. Assure there are no breaks in the seals on the control compartment doors that would permit moisture to enter.

3. Assure winter/summer doors are in proper position.

4. Assure fuel heater (if installed) is operating properly.

5. Assure proper oil (for cold weather service) is used in the governor (5W-30 or 10W-30 depending on railroad cold weather service requirement).

6. Assure fuel filters are clean.

7. Assure fuel strainer is clean.

NOTE: *The fuel oil pressure gage must indicate 25 psi minimum in Notch 8 when checked on self-load or the Load Box. If not, recheck cleanliness of fuel filters and strainer.*

8. Assure horsepower is proper for each notch. There should be no engine bogging. If governor modulation occurs, check lube-oil filters for cleanliness. If dirty, replace filters. If horsepower is low, check engine rpm. Also, assure rpm at IDLE is correct. See Note below.

NOTE: *Low idle speed will cause road shutdown when returning to IDLE. Correct speed is 450 rpm; tach drive is 668 rpm.*

9. Assure battery is in good condition and is fully charged.

10. Assure voltage regulator is operating properly (74 vdc at IDLE).

11. If permitted by railroad rules, add alcohol to fuel tank to prevent freezing (usually one gallon of alcohol per 1000 gallons of fuel).

12. If engine cranks without starting, check the overspeed link. The overspeed governor pressure may reach 200 psi. If the link becomes fully compressed at a greater psi than 120 or does not fully compress, replace the overspeed link. If the pressure is less than 95 psi, replace overspeed governor regulating valve.

NOTE: *Oil pressure during cranking (without manual rack assist) should not be less than 95 psi or less than 175 psi when engine reaches IDLE speed. An oil pressure of 200 psi, or higher, is considered standard. (See GEMS, Volume III, Issue 4 dated December 10, 1974.)*

NOTE: *If the equipment has been properly maintained and the above 12 steps have been performed satisfactorily, a single man start from the operator's cab will be possible.*

ENGINE RUN CHECK

After the Preliminary Check(s) have been completed and if everything appears to be normal up to this point, proceed with the following:

1. Run the engine up to the eighth Throttle notch (no load) and read all gages for normal settings. Return the Throttle handle to IDLE.

2. If everything still appears to be normal, set locomotive brakes, set-up for power, open throttle to Notch 1 and check that loadmeter reads up scale to normal Notch 1 current (approximately 300 amps.). Return the Throttle handle to IDLE.

If reasonably sure that there are no malfunctions with the engine, proceed with the electrical and locomotive systems checks.

TABLE XII-III, EXHAUST SMOKE ANALYSIS

Indication	Possible Cause	Correction
Black smoke puffs.	One or more defective injectors.	Recondition or change the defective injector.
	Fuel pump rack is stuck.	Free the rack or change the pump.
	Fuel pump rack is set too high.	Locate the high rack and readjust.
	Fuel pump is out of time.	Adjust timing.
	Worn or damaged turbocharger.	Repair or replace the turbocharger.
	Broken or leaking manifold pipes.	Repair or replace the manifold.
	Engine speed is bogging down.	Check the engine operation and circuits for fault.
	Turbocharger is surging.	Inlet ports partially blocked or turbo misassembled (check nozzle ring and diffuser). Clean inlet ports, if dirty.
	Turbocharger rotor is stuck.	Replace turbocharger.
White smoke puffs.	Fuel pump is out of time.	Adjust timing.
	Cylinder with valves burned or stuck open.	Replace cylinder.
	Engine is too cold.	Wait until engine warms up.
	Cylinder with low compression.	Replace cylinder.
	Fuel system is air bound.	Bleed the fuel system.
Blue smoke exhaust and oil out the stack.	Failed turbocharger bearings and seals.	Replace turbocharger.
	Worn or broken piston rings.	Replace rings.
	Cracked piston crown.	Replace piston and rings.
	Scored liner.	Replace cylinder and rings.
	Prolong operation of the engine at IDLE.	Load engine and condition should clear-up.
Steady smoky exhaust stream.	Worn or leaking injectors.	Change the injectors.
	Late pump timing on all cylinders.	Time the engine pumps.
Water out of stack.	Cylinder seal leaks, cracked turbo, etc.	Locate and correct.
"Blow" in exhaust system.	Broken exhaust manifold section.	Repair or replace the manifold or manifold section.
	Valve tappet clearance is insufficient.	Readjust.
	Cylinder valve is stuck open.	Replace cylinder.
	Cylinder valve seat is "guttered."	Replace cylinder.

LOADING UNIT OR SELF-LOAD CHECK

It is assumed all controls and devices are properly set and an inspection of items such as water level, oil levels and battery voltage, have been performed.

NOTE: *For detailed instructions, refer to Section XI of this composite manual.*

Start engine, run at IDLE and check:

1. Lube-oil pressure (25-35 psi with water at normal temperature).
2. Fuel pressure (approximately 40 psi).
3. Smoke from stack (Table XII-III).
4. Sound from engine such as heavy pound, rap, knock or clatter (audible indicators of trouble).
5. Pop-test cylinders and observe exhaust for smoke (Table XII-III).
6. Voltage regulator volts (73.5-74.5 vdc).
7. Water, fuel and oil leaks.
8. Governor oil for proper level and cleanliness.
9. Rack readings of fuel injector pumps.

Slowly move Throttle handle to Notch 8 and check:

1. Lube-oil pressure (90-115 psi, or higher if oil is cold).
2. Fuel pressure (25-36 psi).
3. Turbo air pressure (20-32 psi; pressure will vary with atmospheric pressure and temperature).
4. Water temperature (170-180 F).
5. Engine air filter service indicator not tripped.
6. Brake cylinder pressure (45 psi minimum).
7. Cycling of air compressor.
8. Exhaust smoke (Table XII-III).
9. Air flow out of radiators (no debris or dirt in air passages).
10. Air manifold leaks including turbo elbows.
11. Exhaust manifold leaks.
12. Water tank sight glass for traces of oil or carbon.
13. Governor load pot position (at maximum field).
14. Power, voltage and current from CHEC Panel test points to check loading and excitation.

Move Throttle handle to IDLE, then move it to Notch 8 and observe:

1. Exhaust smoke (Table XII-III).
2. Time required for full horsepower.
3. Engine speed stability (hunting).

Move Throttle handle to IDLE and then perform engine shutdown procedure.

HORSEPOWER TROUBLE

No Horsepower (Engine Running)

Open throttle to see that engine responds, contactors pick-up, and loadmeter indicates up-scale. If engine does not respond to notch speeds, check engine controls to ensure that all breakers and switches are in proper operating position. Also, check the output of the voltage regulator panel for 74 vdc battery charging voltage.

Shut the engine down:

1. Inspect throttle control wiring for continuity
2. Check that governor solenoids are operating properly
3. Check that governor plug is properly seated.

If the engine responded to the throttle but no load, shut the engine down and check:

1. Exciter brushes
2. Alternator slip ring brushes, or generator brushes
3. Control air pressure
4. Contactor and relay sequence
5. Assure Generator Field, Control and Excitation breakers are closed.

Then crank the engine and, under no load condition, check the output from the alternator/rectifier circuit (GA and GN wires) with the engine at IDLE and at Notch 1 thru Notch 8 positions.

NOTE: *Refer to the Rectifiers, Exciter, and Alternator sections of the applicable locomotive schematic for location of test points to measure GA/GN voltage. A 1500 vdc meter is needed for this test. Voltage readings at Notch 8, no load, will vary from 1200 vdc to 1500 vdc depending on model of locomotive. Refer to Load Testing, Section XI, for voltages for each model of locomotive.*

Excitation panel cards:

A quick check here involves setting locomotive up to load and open throttle to Notch 1. With a voltmeter check signal from throttle stand, governor, etc., through the excitation system until the signal is lost; then go back one step and find the trouble.

Low Horsepower (Engine Running)

Check:

1. Power Limit switch is in NORMAL position.
2. Motor cut-out switch for "ALL-IN" position
3. Engine is not smoking and sounds normal
4. Reduced excitation indicator light on EC panel and on Annunciator Panel is not lit.

Shut the engine down:

1. Check that rack linkage is not binding

2. Visually inspect engine for evident defects (manifold leaks, disconnected fuel pump control links, etc.)

3. Check paper air filter "Red Flags" for dirty air filters.

Start the engine and advance throttle to about one-half speed (no load) and check:

1. That overspeed link is fully compressed

2. Turbo discharge piping and fitting and the intake manifold for leaks (you will be able to feel and, perhaps, see or hear them)

3. Remove plug from bottom of the turbo-compressor casing and feel that the air is pulsing out of the hole with no oil or water present – if okay, replace plug – if not, further investigation of the turbo will be necessary.

With the engine running top speed (no load), check fuel pressure (assuming the gage is not defective). If there is more than a three pound difference between IDLE and top speed readings, the engine is probably not receiving sufficient fuel under load conditions. Determine why; e.g., dirty fuel filter or strainer, low regulator settings, etc.

If the problem develops between 20 to 30 mph, check transition settings with test set.

If nothing is found up to this point, the unit should be connected to the load box or self-load for further checks. Refer to Load Testing, Section XI. One thing to remember is that under load conditions:

1. If the load pot is below maximum field, the problem is usually mechanical

2. If at maximum field, the problem is usually electrical

3. If the horsepower is high, there may be both mechanical and electrical problems.

TURBOCHARGER TROUBLE

General

When mounted in the locomotive, the turbocharger, Fig. XII-1, is a difficult piece of equipment to check quickly and qualify for continued service. The turbocharger is frequently judged to be faulty on the basis of operating crew reports or on the basis of symptoms noted while the locomotive is being operated during the inspection process. While the symptom noted may identify a defective turbocharger, it has frequently happened that the same symptom applies to other faults on a locomotive, so many turbochargers are replaced unnecessarily. Refer to Table XII-IV for examples of symptoms showing multiple faults.

Inspection On Locomotive

The preferred method of qualifying a turbocharger for continued service is to observe it (and its effects) while load-testing the locomotive. Load-testing (refer to Load Testing, Section XI) should only be performed after first establishing the following items are functioning and correct:

1. Fuel pump racks – correctly set and equal
2. Fuel pumps – properly timed
3. Fuel-injection pumps and nozzles – all must function
4. Air-intake and exhaust manifolds – free of leakage
5. Valve tappet clearance – correctly set
6. Fuel filter and engine air filters – cannot be plugged
7. Fuel linkage – free moving
8. Excitation circuits – must be in good order and capable of being adjusted.

When under FULL LOAD and in Notch 8, observe turbocharger air pressure, color of exhaust gases, governor load pot action, and check the turbocharger for oil and water leakage and mechanical distress. Use Table XII-IV to identify a faulty turbocharger or other locomotive component.

When it is not possible to load test the locomotive, perform the following turbocharger check, with the locomotive shut down:

1. Working down thru the stack, use a flashlight and a mirror positioned to observe the turbine-disk blades, Fig. XII-2. While observing the blades, use a hook tool, made from 1/8-in. diameter stainless steel, to lift and rotate rotor thru one complete revolution. Examine all blades for possible damage caused by foreign material, and check rotor for free rotation. Performing this operation will often break up carbon build-up (which causes reduced rotor speed) and allow continued use of the turbocharger.

2. Remove the clamps, flexible duct, and air duct from the compressor end of the turbocharger, Fig. XII-3. Manually turn the rotor, and note that rotor is free to rotate. Set up a dial indicator and move the rotor, as required, to check the axial and radial clearance.

TABLE XII-IV, TROUBLE-SHOOTING THE TURBOCHARGER

Crew Report Or Symptom	Actual Turbocharger Fault	Possible Cause Of Turbocharger Fault	Other Possible Locomotive Faults
Black smoke out stack (steady-state).	- Rotor not turning. - Rotor turning at reduced speed.	- Rotor damaged by foreign object - Excessive carbon build-up between turbine seal and disk - Failed bearings - Failure of rotor turbine disk or compressor wheel - Compressor wheel or turbine disk rubbing	- Injection pumps not properly timed - Faulty fuel injection pumps and/or nozzles - Excessive carbon build-up in air intake ports - Dirty intercoolers - Plugged engine air filters - Leakage in air-intake manifold - Faulty excitation circuit adjustments or components
Not loading or low on power.	- Rotor not turning. - Rotor turning at reduced speed.	- Rotor damaged by foreign object - Excessive carbon build-up between turbine seal and disk - Failed bearings - Failure of rotor turbine disk or compressor wheel - Compressor wheel or turbine disk rubbing	- Dirty or plugged fuel filter - Fuel pump racks set incorrectly - Valve tappet clearance set incorrectly - Leak in manifold line to governor - Also, see faults listed above for "Black smoke out stack"
Blue smoke, and oil, out stack.	- Failed bearings and/or seals.	- Pipe plug missing in upper cavity of forward-end cover - Wrong size orifice in lube-oil supply pipe - Rotor unbalance	- Worn or broken piston rings - Cracked piston (crown) - Scored liner
	- Seal air passage plugged with carbon. - Labyrinth in turbine-end seal plugged with carbon.	- Prolonged operation of engine in idle and lower speed notches	
Low turbocharger air pressure (At Notch 8, FULL LOAD).	- Rotor turning at reduced speed.	- Excessive carbon build-up between seal and disk - Defective bearings - Compressor wheel or turbine disk rubbing	- Leakage at air discharge elbows or in air-intake manifolds - Leakage in exhaust manifold - Faulty gage - Also, see faults listed above for "Low on power"
Low turbocharger air pressure (At less than Notch 8, FULL LOAD).	Possibly, no fault. Turbocharger air pressure is not indicated until in Notch 6, and above, and under load. There is no indication when in dynamic braking.		

Refer to Data section and Torque Values section for limits.

WARNING: *When using compressed air for cleaning purposes, an environment potentially hazardous to personnel in the immediate area is created. To prevent physical injury by flying debris, observe all Railroad and OSHA safety regulations.*

3. Check for plugged seal-air passages. Disconnect the seal-air pipes and apply shop air into the seal-air passages in the turbine casing. If passages are clear, the sound of escaping air will be heard at the stack outlet. This operation can often clear a partially-blocked passage.
4. Check visually for evidence of mechanical damage, excessive heat and water leaks.

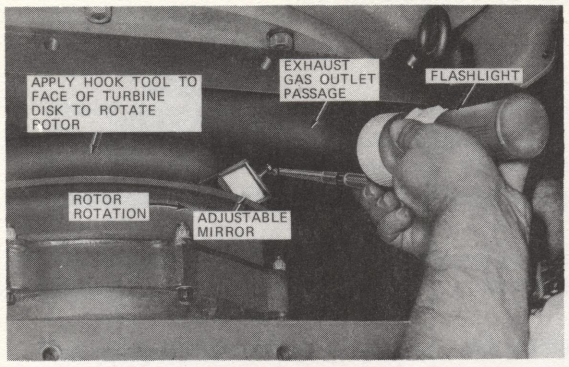

FIG. XII-2. INSPECTING TURBINE-BUCKET BLADES.

Data

	English	Metric
Weight, turbocharger	1470 lb.	667 kg
Rotor, end-play:		
New	0.013-0.021 in.	0,330-0,533 mm
Max. worn	0.025 in.	0,635 mm
Rotor, diametral clearance in bearings:		
New	0.003-0.0055 in.	0,076-0,140 mm
Max. worn	0.0065 in.	0,165 mm
Speed pick-up probe to cap, clearance	0.028-0.090 in.	0,711-2,286 mm
Oil-supply pressure, measured at turbine-casing inlet, with oil at normal operating temperature of 160-190 F (71-88 C),		
with engine at IDLE	10-20 psi	69-139 kPa
with engine at N8	15-40 psi	103-276 kPa

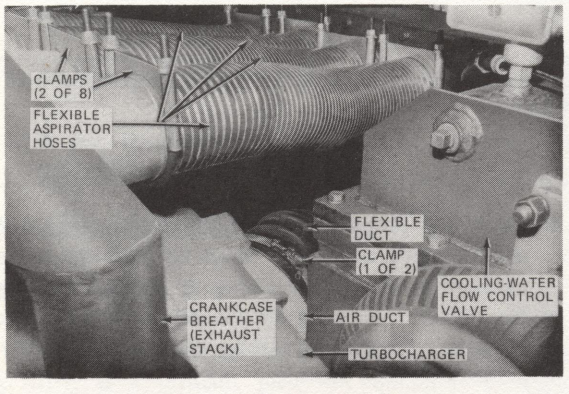

FIG. XII-3. TURBO INSTALLATION DETAILS, COMPRESSOR END.

Torque Values

	Lb.-Ft.	N·m
Bolts, turbocharger mounting	150-165	203-224
Bolts, stack clamping	55-60	75-81
Bolts, exhaust manifold to turbocharger	70-75	95-102
Nuts, stud-locking and ear-clamping, air-discharge elbows	55-60	75-81
Bolts, flange to intercooler	35-40	47-54

MODULATING CONTROL GOVERNOR TROUBLE

The modulating control governor is an electro-hydraulic device used to regulate speed and horsepower output of the diesel engine. It also includes a number of auxiliary devices such as a Water Pressure Switch (WPS) and an Oil Pressure Switch (OPS) to protect and provide the power plant with characteristics desirable for railway locomotive service.

These characteristics, devices and operational events are shown in Fig. XII-4. This figure consists of four tracking charts that show normal and abnormal operating events and what action should be taken to correct the abnormal events. The four tracking charts are:

1. Normal Conditions – Power
2. Engine Start
3. Normal Conditions – Dynamic Brake
4. Hot Engine Controls.

CHEC EXCITATION SYSTEM TROUBLE

The major component in the CHEC excitation system is the FL138 Excitation Panel. Therefore, emphasis has been placed on the trouble-shooting of the panel.

Table XII-V lists the ten cards in the panel and their function. The first nine cards are the same in all panels for the different models of General Electric locomotives. The tenth, or Reference Card, is different for each model of locomotive and for each model of the FL138 Excitation Panel (Table XII-VI).

NOTE: *The maintainer should not assume, for example, that all C30-7 Locomotives will have the same model of the FL138 panel and, thus, the same type of Reference Card. The model of the FL138 Panel installed on the C30-7 Locomotive depends on the type of turbocharger installed.*

CAUTION: *Power should be removed when pulling or replacing electronic cards, to prevent electrical damage to the cards or their contacts in the panel.*

FIG. XII-2, E-23320

FIG. XII-3, E-24460

XII

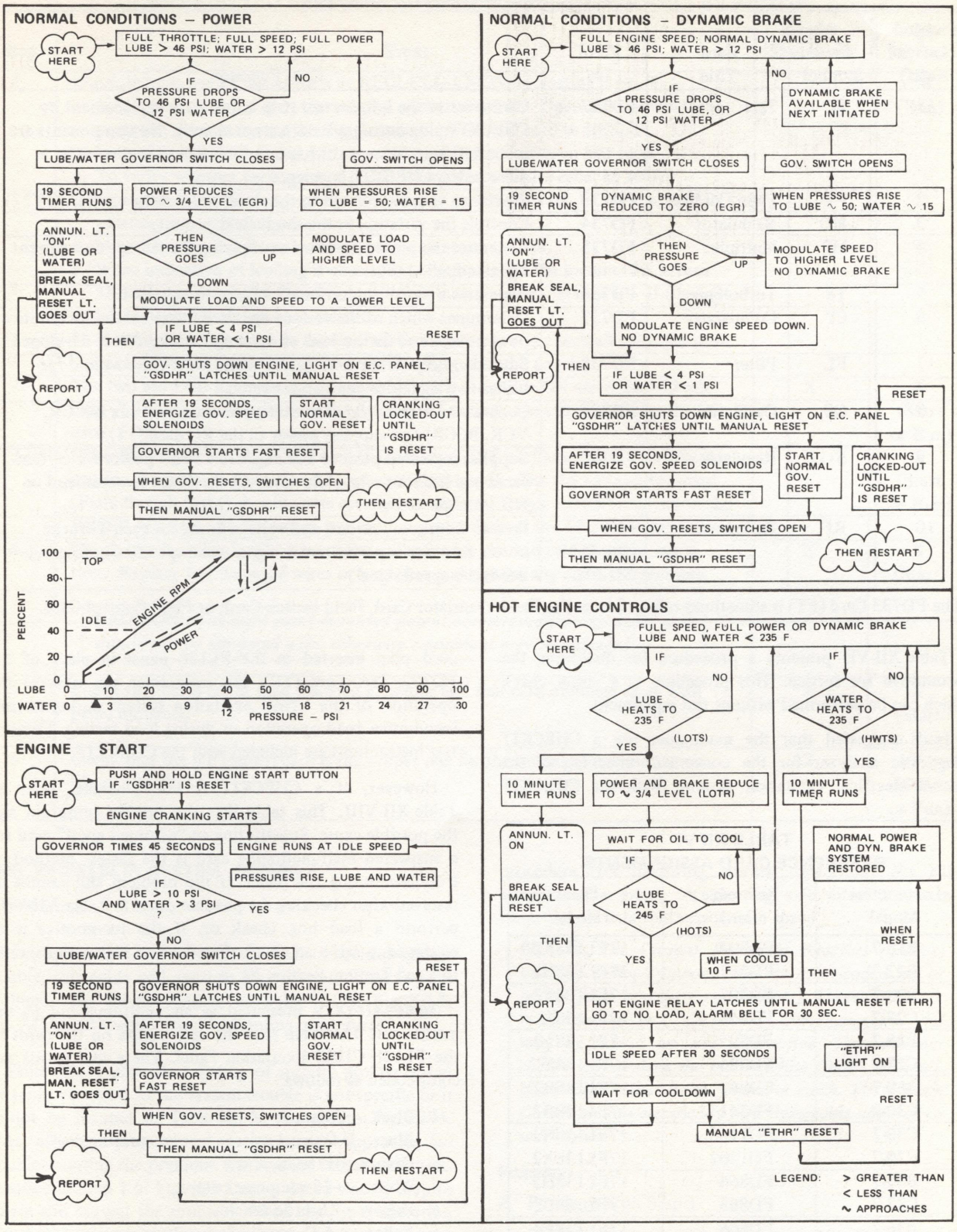

FIG. XII-4, E-24665

FIG. XII-4. ENGINE MODULATING GOVERNOR TRACKING CHARTS.

XII

TABLE XII-V, CARD DATA AND FUNCTION

Position (Left to Right)	Card Symbol	Card Title	Card No.	Card Function
1	TC	Test	FD732	Card reserves the left contact strip in panel for replacement by CHECKIT plug during system tests or checks. No components are mounted on it; however, it has interlock wiring, and must be in place unless CHECKIT is plugged in.
2	FT	Field Control*	FD733	Provides a variable current to the shunt field of the exciter (GY27).
3	MD	Modulator	FD734	Controls the variation in the shunt field current.
4	MP	Multiplier	FD735	Generates the power signal by multiplying the voltage and current signals supplied to it.
5	TS	Turbo Speed	FD736	Generates a signal proportional to turbo-rotor speed.
6	CP	Comparator	FD737	Determines which of the various signals will control the locomotive power output or the amount of dynamic braking effort developed.
7	FL	Filter	FD738	Smooths signals from ACCR, BCCR and VCR reactors and furnishes two signals to comparator card.
8	OS	Oscillator	FD739	Generates a 400 Hz signal to excite the three reactors (ACCR, VCR, BCCR) and supplies power to the RG card.
9	RG	Regulator	FD740	Supplies regulated positive and negative 15 volt power for certain cards and has four relays which repeat the Throttle command on MU trainline wires.
10	RF	Reference	FD—— (See Table XII-VI).	Presets the power, current and voltage limits for each Throttle notch, furnishes a power match signal when specified, and modifies turbo speed signal.

*The FD733 Card (FT) is sometimes referred to as the Field Transistor Card, Field Switch Card, or Field Control Card.

Table XII-VII presents a procedure for qualifying the locomotive for service. This procedure is a visual check which can be performed without test equipment.

It is suggested that the maintainer use a CHECKIT diagnostic analyzer for the convenient checking of the overall electrical excitation system. With the CHECKIT cord plug inserted in the FL138 panel in place of the FD732 Test Card (TC), the maintainer can observe the operation of the CHEC excitation system during normal locomotive road operation or during load testing. Detailed test instructions are included with the CHECKIT.

However, if a CHECKIT is not available, refer to Table XII-VIII. This table lists the trouble symptom and the possible cause. Substituting an "assumed good" card for a suspected malfunctioning card is the fastest method of trouble-shooting the panel. If the problem still cannot be resolved after checking the possible cause in Table XII-VIII, perform a load box check or, if the locomotive is so equipped, a self-load check. For detailed instructions, refer to Load Testing, Section XI.

Table XII-IX is presented as an additional aid to the maintainer. The table lists the test points on the cards in the FL138 CHEC Excitation Panel. These test points are color-coded as follows:

1. Black – Common
2. Blue – D-C signal voltage from measuring device
3. Orange – +15 vdc power supply
4. White – –15 vdc power supply
5. Brown – Throttle notch
6. Yellow – A-C, usually for oscilloscope use
7. Green – D-C reference voltage.

TABLE XII-VI
REFERENCE CARD ASSIGNMENTS

Locomotive Model	Reference Card	Panel Model
B18-7	FD894	17FL138K2
B23-7	FD867	17FL138H2
B23-7	FD897	17FL138T2
C23-7	FD868	17FL138J2
B28-7	FD895	17FL138L2
C28-7	FD896	17FL138M2
B30-7	FD862	17FL138B2
C30-7	FD741	17FL138A2
C30-7	FD1146	17FL138N2
C30-7	FD1202	17FL138X2
B33-7	FD864	17FL138D2
C33-7	FD863	17FL138C2
B36-7	FD866	17FL138F2
C36-7	FD865	17FL138E3

TABLE XII-VII, PROCEDURE FOR QUALIFYING LOCOMOTIVE FOR SERVICE

Step	Event	Engine Shutdown	Engine Running
1.	Check locomotive EC panel for a lit REDUCED EXCIT. indicating light. a. If lit, the locomotive is in the reduced excitation mode. Open the Control Compartment door and press the Toggle switch on the MD card to RESET. b. Indicating light will go out with operation of Reset Switch on MD card. c. To verify whether fault remains or has cleared, locomotive must be set for motoring, air brakes set, reverser thrown, GF in ON position, EC switch in RUN position and isolate all other units. d. Move Throttle handle to Notch 1, until unit starts to load. e. When indication of loading is observed on loadmeter of the locomotive, return Throttle handle to IDLE and note whether indicating light is now lit. If the light is not lit, the fault has been cleared. f. If indicator relights, go to the Control Compartment and check all cards for proper location and assure they are securely plugged in the panel.		X (Run)
2.	The two red LED lights on the RG card (FD740) should be ON when the +15 vdc and −15 vdc power supplies are functioning. If not, change out this and/or the OS card (FD739).	X	X (Start or Run)
3.	Move the Toggle switch on MD card (FD734) to TEST position to simulate a fault, causing the panel to go to the reduced excitation mode. The red LED on this card (Field Switch Light) should come on and stay lit until Toggle switch is moved to the RESET position. As the switch is moved, you should hear the EF relay operate.	X	X (Start or Run)
4.	Check terminals for loose connections and wires for charred or discolored insulation. Replace any damaged wires or hardware and tighten any loose connections. **CAUTION:** *The eight panel-mounted potentiometers are factory sealed and should not be tampered with, otherwise equipment may be damaged.*	X	X (Start)
5.	Check that cards are in their assigned locations and that card numbers agree with panel numbers.	X	X (Start or Run)
6.	Check that the RF (tenth) card is the proper one for the model of locomotive on which installed.	X	X (Start or Run)

CMR WHEELSLIP SYSTEM TROUBLE

Introduction

If a locomotive has a report of CMR wheelslip system trouble, this guide will assist in locating and correcting the problem. The guide consists of Table XII-X, Fig. XII-5, Fig. XII-6 and specific trouble-shooting procedures.

Table XII-X presents a listing of specific problems that are fairly common. If the system trouble is not specific or it cannot be located in Table XII-X, proceed to Fig. XII-5. This figure presents a programmed approach to trouble-shooting the problem. Observe the initial conditions specified in Step 1 of Fig. XII-5 and proceed step by step to isolate and correct the problem. When abnormal operation occurs, the horizontal line shown by the applicable step on Fig. XII-5 will reference a specific trouble-shooting procedure for restoring normal operation. Fig. XII-6 consists of a graph for plotting axle alternator output frequency or axle rpm versus train speed.

NOTE: *The Current Measuring Reactors (CMR's) used on Series-7 Locomotives are color-coded red or white (from two different vendors). These CMR's are mechanically and electrically interchangeable and may be mixed on any locomotive. The customer should not replace the red or white CMR's with any black CMR's that he may have in stock. These black CMR's are not electrically interchangeable with red or white ones.*

Procedures

A. Problems With Step 1

The problem is with transistor Q1. On a six-axle locomotive, replace the FD1154 Card located in the

TABLE XII-VIII
CHEC EXCITATION SYSTEM TROUBLE

Symptom	Possible Cause	
	Excitation Panel	External Circuits
No power in any notch.	RG, MD, FT, or RF card defective.	Open exciter shunt field circuit. Worn-out or broken exciter brushes. Governor plug not in place. GF, GFA open.
Very little power in any notch.	FT or TS card defective.	Open exciter shunt field circuit. No signal of turbo speed.
Less than normal power in most or all notches.	TS or MD card defective.	Fuel filter partially blocked or fuel suction leak (LCP will be at minimum). Low battery voltage. One magnet missing from turbo rotor.
Normal power and current in some notches; higher or lower than normal in others.	RF or RG card defective.	Open circuit in wires to coil of relays RLA, RLB, RLC, or RLD on RG card. Failure of these relays to operate properly.
Excessive current in all notches.	OS or CP card defective.	Open OVDR resistor. Open secondary in ACCR. Shorted VCR. No feedback from ACCR and/or VCR.
Load Control Potentiometer reads toward minimum field.	MP card defective.	
No or very low braking current.	CP card defective. Open P5 or P6 potentiometer in adjustment module.	Open feed wires to positive end of braking potentiometer. Open feed wire to EXP-AB terminal. Shorted RFC3 or AMC1 capacitor. Open motor field circuit. Open grid circuit (with CMR). Wrong CP2 contactor sequence.
Maximum braking in any handle position.		Open connection to negative end of braking potentiometer.
Braking current in red zone of loadmeter.	OS or CP card defective.	Open BCCR control winding.
Dynamic braking current hunts.	MD card defective.	Open circuit to L2 reactor in excitation panel

TABLE XII-VIII (Cont'd.)

Symptom	Possible Cause	
	Excitation Panel	External Circuits
Dynamic braking works in one direction of locomotive movement, but not in other.		Reverser not completely throwing, perhaps due to leaking air lines or defective magnet valves.

FL80 CMR Wheelslip Panel. On a four-axle locomotive, replace the FD1155 Card located in the FL84 CMR Wheelslip Panel.

Proceed to Fig. XII-5, Step 2.

B. Problems With Step 2

WSX relay is not picking-up. Look for grounds or short circuits. If none are found, replace WSX relay located on CMR wheelslip panel.

Proceed to Fig. XII-5, Step 3.

C. Problems With Step 4

At this point, several possible things could be the cause of the trouble. Therefore, it is necessary for further testing to determine where the fault is located.

1. Return the Throttle handle to IDLE, center the Reverse handle and place the Alternator (Generator) Field (GF) circuit breaker to OFF.

2. Equalize the wheelslip panel inputs from the CMR's by jumpering the following terminals together.

   a. On the FL80 Panel (six-axle locomotive), jumper terminals C-D-E-F-G-H.

   b. On the FL84 Panel (four-axle locomotive), jumper terminals C-D-E-F.

3. Pump-up the air brake system and set the locomotive brakes.

4. Place GF breaker to ON, move Reverse handle to FORWARD or REVERSE and advance Throttle handle to Notch 1.

TABLE XII-IX, CHEC CARDS TEST POINTS

Card Symbol	Card No.	Test Point	Test Point Title	Remarks
TC	FD732	None		
FT	FD733	TP1	SWITCH OUTPUT	Measures Q4 output.
		TP2	COMMON	
MD	FD734	TP1	MODULATOR OUTPUT	
		TP2	COMMON	
MP	FD735	TP1	POWER 300 KW/VOLT	Negative voltage; see Note 1.
		TP2	COMMON	
TS	FD736	TP1	TURBO SENSOR	A-C voltage; turbo speed signal.
		TP2		
		TP3	TURBO 2150 RPM/V	
		TP4	COMMON	
		TP5	POWER REFERENCE	
		TP6	TURBO	
CP	FD737	TP1	I REFERENCE (MOTORING)	Alternator current.
		TP2	V REFERENCE (MOTORING)	Alternator voltage.
		TP3	GRID REFERENCE (BRAKING)	Braking grid current.
		TP4	FIELD REFERENCE (BRAKING)	Braking field current.
		TP5	MODULATOR BIAS	Comparison junction.
		TP6	COMMON	
FL	FD738	TP1	ACCR 600 A/V	Alternator current; see Note 2.
		TP2	VCR, BCCR, MOTORING 150 V/V BRAKE 100 A/V	Alternator volts; see Note 2; braking current.
		TP3	COMMON	
OS	FD739	None		
RG	FD740	TP1	+15 VDC	Regulated supply.
		TP2	−15 VDC	Regulated supply.
		TP3	COMMON	
		TP4		Not used.
		TP5	LOAD POT BRUSH ARM	Governor load pot voltage.
RF	(See Table XII-VI)	TP1	NOTCH 1	
		TP2	NOTCH 2	
		TP3	NOTCH 3	
		TP4	NOTCH 4	
		TP5	NOTCH 5	
		TP6	NOTCH 6	
		TP7	NOTCH 7	
		TP8	NOTCH 8	
		TP9	POWER	
		TP10	COMMON	

NOTE 1: *Horsepower into alternator for traction can be calculated as follows: TP1 volts x 424 = horsepower.*

NOTE 2: *Horsepower into alternator for traction can be calculated as follows:*

$$\frac{\text{TP1 volts} \times \text{TP2 volts}}{708} = \text{horsepower.}$$

NOTE 3: *All measurements are 15 vdc or less except FD736 Turbo Speed Card test points TP1 and TP2 which are a-c. Use 100,000 ohms per volt meter, or higher.*

TABLE XII-X, CMR WHEELSLIP SYSTEM TROUBLE

Symptom	Possible Cause	Correction
At standstill, false wheelslip indication when Throttle handle is moved from IDLE to Notch 1.	Bad wiring at CMR.	Look for loose joints or connections, smoke, heat or other possible clues. Otherwise start with Step 4, Fig. XII-5.
	Wrong motor contactor sequence.	
	Slipped pinion.	
	Open circuit in traction motor.	
	High resistance connection in one of the power circuits.	
	Disconnected motor cable.	
Continuous wheelslip indication when speed reaches a little over one mph.	Locked traction motor.	Check motor rotation.
	Improper motor connections.	Check motor connections.
	Wrong gearing on one or more axles.	Check gearing.
	Wide variation in wheel diameter (more than 1 in.).	Compare wheel diameter.
	Compression bolts not removed from traction motor nose mounts.	Check for compression bolts. Otherwise start with Step 4, Fig. XII-5.
Continuous wheelslip indication at or above certain locomotive speed (usually 50 mph or higher).	Overspeed detection set too low (FD406 Card).	Start with Step 4, Fig. XII-5.
	Wide variation in wheel diameter (more than 1 in.).	Compare wheel diameter.
Continuous wheelslip indication during dynamic braking but not during motoring.	Open braking grid circuit.	Look for grid burned open or disconnected cable. Otherwise begin with Step 9, Fig. XII-5.
Brief wheelslip indication at transition.	Sensitivity set slightly too low. Contactor action is a little slow.	This is not an abnormal condition provided it does not get worse. If it does, start with Step 4, Fig. XII-5.
Brief wheelslip indication at low speeds while in dynamic braking.	Extended range braking contactors not coming in at the same time.	This is not abnormal provided it does not get worse. If it does, start with Step 4, Fig. XII-5.
Steady wheelslip indication at certain speed while in dynamic braking.	Extended range contactors did not operate properly.	Check contactors. Otherwise start with Step 9, Fig. XII-5.
No wheelslip indication with slips known to exist.	Current transformer (CT) failure WSX defective.	Start with Step 1, Fig. XII-5.

5. The FD406 Card located on the FL80 Panel (six-axle locomotive) and on the FL84 Panel (four-axle locomotive) has five test points numbered 1, 2, 3, 4 and Common. The FD408 Card located on the FL80 Panel (six-axle locomotive) has three test points numbered 5, 6 and Common.

   Check voltage between test points 1, 2, 3, 4 and Common on the FD406 Card (and 5, 6 and Common on the FD408 Card, if applicable) with a voltmeter. The meter scale should be selected to read d-c volts between 24 and 30 volts (4 volts for every 100 amperes on the loadmeter in the cab). The maximum difference should not exceed 3 volts, or 7 percent variation from highest to lowest.

6. Proceed with Case No. 1.

NOTE: *Several possible things could be the cause of the trouble. To simplify trouble-shooting, the fault situation has been presented in three "Cases": Case No. 1, Case No. 2 and Case No. 3.*

Case No. 1

If the CMR wheelslip system activates (WSL light is lit, sanding occurs and there is a reduction of excitation), then proceed to Case No. 2. If the CMR wheelslip system does not activate, the problem is localized to the external portion of the CMR system. Proceed with the following:

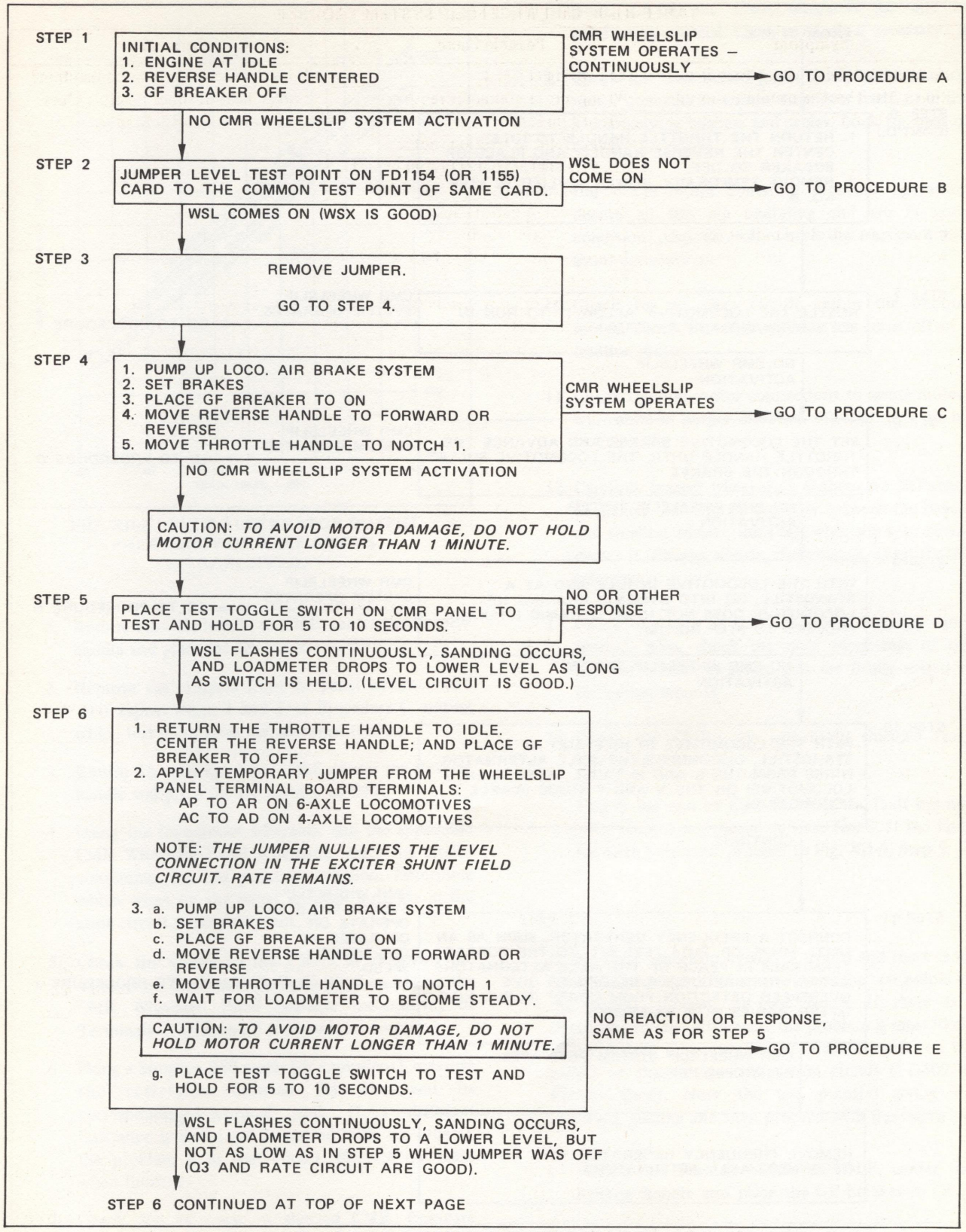

FIG. XII-5, E-25410

FIG. XII-5. CMR WHEELSLIP SYSTEM FLOW CHART.

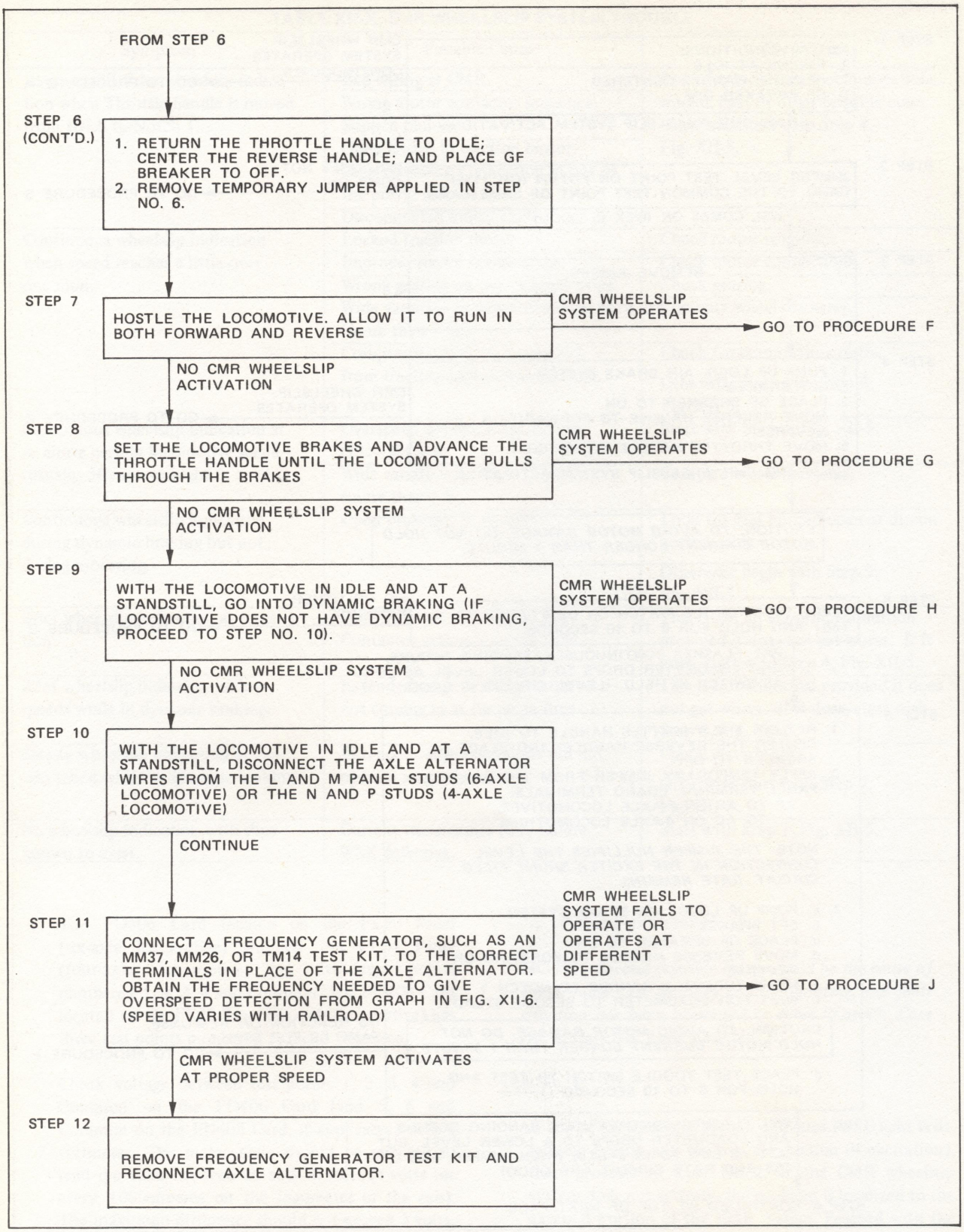

FIG. XII-5. CMR WHEELSLIP SYSTEM FLOW CHART (CONT'D.).

FIG. XII-6, E-18345

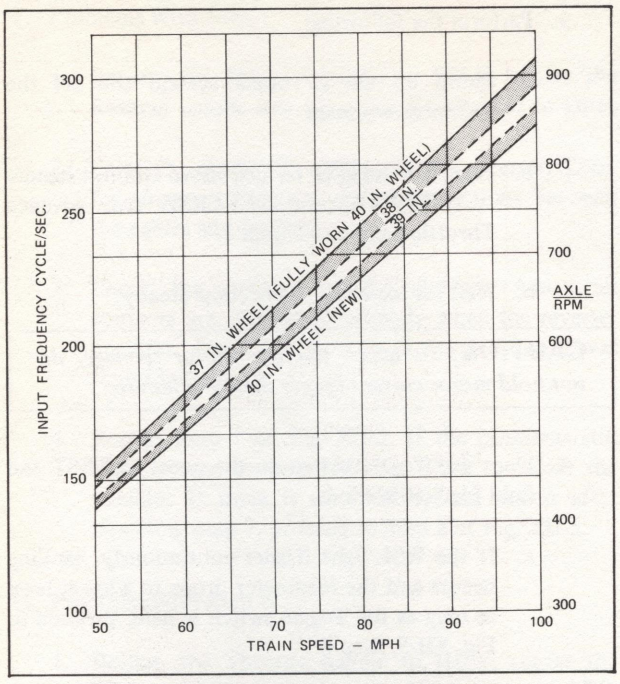

FIG. XII-6. AXLE ALTERNATOR OUTPUT FREQUENCY OR AXLE RPM VS. TRAIN SPEED.

1. Return Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Remove the jumpers from the panel terminals and then repeat Steps 4 and 5 of Procedure C, noting which test point gives the abnormal reading.

3. Return Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

4. Using the locomotive schematic and the applicable CMR Wheelslip Panel schematic, trace the circuit containing the test point in question. Determine which wires on the panel terminal strip are in the same circuit as the test point.

5. Check the wiring to the CMR's by removing the wires from Terminals C, D, E, F, G and H on the CMR Wheelslip Panel (six-axle locomotive) or Terminals C, D, E and F (four-axle locomotive).

6. Using a Simpson 260 meter (or equivalent), measure the resistance between the wire and its corresponding terminal stud. If a different resistance is noted (as compared with the others), the problem is in that circuit. Replace the wires when finished.

7. Check for an open or shorted CMR. Compare resistance measurements with a CMR known to be good. Check the CMR terminals for dirt or conducting material. Clean terminals if necessary.

8. Check for loose bolted joints either in the traction motor connections within the motor itself, or in the accompanying busbars and cables. Look for signs of heat and/or smoke.

9. Check the motor contactor sequence operation. Assure all tips are operating and are in good condition. Also, carefully check the traction motor shunt connections.

10. Check for an open circuit within the traction motor. Check to see if a pinion has come off of a traction motor.

11. Check traction motor connections to assure motors will rotate in proper direction and that there are no locked axles.

12. Carefully inspect wheel sizes. If there is a difference of greater than one in. diameter between the largest and smallest wheels, the CMR wheelslip system will detect it. Change wheels, if necessary, to satisfy the tolerance.

13. Check to assure all traction motors have the same gearing. Also, check the nose mountings of the traction motors to assure they are firmly seated in the rubber mounts.

14. Check the CMR's are effectively shielded from nearby cables.

This is the end of Case No. 1. If the fault has not been corrected, proceed to Case No. 2. If the fault has been corrected, proceed to Fig. XII-5, Step 5.

Case No. 2

If the CMR wheelslip system activates and there is no significant voltage difference between the test points on the card(s), proceed to Case No. 3. If there is a significant voltage difference, the problem is most likely in the current measuring circuit (transformer(s) on the panel) or the voltage comparison circuit (FD409 or FD410 Card). Note the test point(s) giving the abnormal reading and then proceed with the following.

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Remove jumpers from panel terminals.

3. Assure all wires on the panel terminal strip are firmly fastened.

4. Using a Simpson 260 meter (or equivalent), check the winding continuity of the panel transformers. Especially check the transformer in the circuit with the abnormal reading.

5. Remove all the cards from the panel and visually check for burned or damaged components. Especially check the filter capacitors on the FD409 Card (six-axle locomotive) or the FD410 Card (four-axle locomotive). Also, check the plug connection pins on each card to assure they are not bent or broken. Replace any defective card.

6. Replace all the circuit cards in their proper slots and assure they are secured in the panel.

   This is the end of Case No. 2. If the fault has not been corrected, proceed to Case No. 3. If the fault has been corrected, proceed to Fig. XII-5, Step 5.

Case No. 3

The lack of a significant voltage difference indicates the problem is in one of the detection circuits (Level, Rate or Overspeed). Proceed with the following:

1. Return the Throttle handle to IDLE, center the Reverse handle and place GF breaker to OFF.

2. Remove jumpers from panel terminal.

3. Repeat Step 2 of Fig. XII-5 to double-check WSX relay is operating properly. If it is not, replace it.

4. If no faults have been found to this point, replace the FD1154 Card (six-axle locomotive) or the FD1155 Card (four-axle locomotive) with an "assumed good" card.

   Proceed to Fig. XII-5, Step 5.

D. Problems With Step 5

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Replace the FD1154 Card (six-axle locomotive) or the FD1155 Card (four-axle locomotive) with an "assumed good" card.

3. Perform the following:

   a. Pump up the air brake system and set the locomotive brakes.

   b. Place GF breaker to ON, move Reverse handle to FORWARD or REVERSE and advance Throttle handle to Notch 1.

   c. Wait for loadmeter to become steady.

CAUTION: *To avoid traction motor damage, do not hold motor current longer than one minute.*

4. Place test Toggle switch on the panel to TEST and hold for 5-10 seconds.

   a. If the WSL light flashes continuously, sanding occurs and the loadmeter drops to a lower level as long as the Toggle switch is held, proceed to Fig. XII-5, Step 6.

   b. If there is no response, proceed with the following:

      1) Shut down locomotive completely.

WARNING: *Do not proceed unless locomotive is dead. This avoids potentially dangerous voltages which could cause serious or fatal injury.*

      2) Check for open circuit condition in wiring between panel and current transformer.

      3) Check diode rectifier bridge 5BR1 which is located on the side of the panel.

      4) Restart the engine; observe standard railroad procedure and precautions.

      5) Perform the initial conditions of Step 1 of Fig. XII-5 and then return to Step 4 of Fig. XII-5.

E. Problems With Step 6

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Replace the FD1154 Card (six-axle locomotive) or the FD1155 Card (four-axle locomotive) with an "assumed good" card.

3. Repeat Steps 4, 5 and 6 of Fig. XII-5.

F. Problems With Step 7

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Carefully check the cabling to the reverser. Look for shorts, grounds or loose connections between the cables and busbars.

3. Check the contacts of the reverser. Assure all contacts are picking-up properly when the reverser operates. Leave the reverser in the position it was found initially.

4. Repeat Step 7 of Fig. XII-5. If the problems still exist, return to Step 4 of Fig. XII-5 to locate the trouble. If there is no CMR system action after repeating Step 7, proceed to Step 8 of Fig. XII-5.

G. Problems With Step 8

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Carefully check the CMR's. Either one or more of them are not giving the proper signals at higher traction motor currents.

3. Repeat Step 8 of Fig. XII-5. If the problem still exists, return to Step 4 of Fig. XII-5 to locate the trouble. If there is no CMR system action after repeating Step 8, proceed to Step 9 of Fig. XII-5.

H. Problems With Step 9

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Carefully check the cabling and busbars of the dynamic braking circuits to the traction motors. Look for grounds and loose bolted connections.

3. Check the extended range braking contactors are operating properly.

4. Check for an open circuit in the braking grids; either a grid is burned open or a cable is burned off.

Proceed to Fig. XII-5, Step 10.

J. Problems With Step 11

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.

2. Use a 44-pin card extender and extend the FD406 Card from the panel.

3. With the frequency generator Test Kit still connected, set the frequency to the proper value as indicated on Fig. XII-6.

4. Adjust the card potentiometer until the CMR wheelslip system activates with a small increase in frequency above the proper value.

5. If the wheelslip system is not responsive to any setting of the potentiometer, replace the FD406 Card with an "assumed good" card. Set the potentiometer on the replacement card as specified in Steps 3 and 4 above.

6. Disconnect the card extender, replace the FD406 Card in the panel.

Proceed to Fig. XII-5, Step 12.